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Portuguese Capital in the XXIst Century: A Tale of Misallocation?

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Abstract

We analyze the patterns of productivity in the Portuguese manufacturing sector from 2006 to 2017. With a more comprehensive firm-level dataset and with a larger time-span, we confirm the findings of Gopinath et al. (2017): there is evidence of increased capital misallocation. However, we show that the results hinge critically on the capital stock measure used. Relying on an improved measure, we find two key results, contradicting the initial ones: (i) a declining economic potential of the manufacturing firms, measured by an hypothetical efficient-level TFP, likely driven by the destruction of productive capital during the period; and (ii) a reduction in capital misallocation, as actual TFP declined less than the theoretical one.

Keywords*: Productivity; Capital; Misallocation.*

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1 Introduction

At the beginning of the XXIst century, Portugal halted its period of convergence with the most advanced economies (Blanchard, 2007). Since 1960, the Portuguese economy partially converged to the European average GDP per capita, from 39% in 1960 to 70% in 2000 (Inklaar et al., 2018). Convergence was mostly driven by capital deepening (i.e. more capital stock per worker), not by productivity. Indeed, in the early 2000s, the differences between the Portuguese GDP per capita and that of the United States, Germany and Spain were half explained by the lack of Total Factor Productivity (TFP) growth (Reis, 2011). From 2001 to 2013, Portugal grew relatively less than the US during the Great Depression (Reis, 2013). In 2017, Blanchard revisited his paper of 2007 and found that productivity was still an important obstacle to economic growth in Portugal (Blanchard and Portugal, 2017).

The misallocation of capital due to the single European currency may provide a narrative behind the lack of TFP growth. Gopinath et al. (2017) use firm-level data to document an increased dispersion of the marginal rate of productivity of capital (MRPK) in southern European countries, pointing to problems in the efficient allocation of capital among firms.[1] In the second half of the nineties, these countries borrowed heavily due to the liberalization of capital flows and the lower perceived risk associated with the upcoming euro adoption (Blanchard and Portugal, 2017). The effect was reinforced in the 2000s as southern economies, who had historically higher nominal interest rates, converged to the low-interest rates of countries such as Germany (Moravcsik, 2012), allowing economic agents to borrow at a lower cost. The availability of funds at low cost potentiated the allocation of capital to the least productive uses.

In recent years, empirical research argues that, during a financial crisis and in the presence of significant misallocation of capital, the expected cleansing effects of the crisis may be counterbalanced by a process of bank forbearance. It was first documented in Japan, during its lost decade, from 1990 to 2000 (Caballero et al., 2008). The European sovereign and financial crisis uncovered the problem also in European countries, as under-

[1]Dias et al. (2016b) explore the output gains in the Portuguese economy of equalizing Total Factor Productivity Revenue (TFPR) within firms, calculating the reallocation gains if the distortions that cause the dispersion of TPFR did not exist.

capitalized banks continuously lend to financially stressed, low-productivity firms to keep the bank capital adequacy levels acceptable to the regulator, entering in a practice labelled as zombie lending (Acharya et al., 2019). According to neo-Schumpeterian theory, these firms would be forced to close the productivity gap with the more efficient firms operating in the market or to exit. However, due to the distortions in the financial markets, they do not do either. Zombie firms congest markets, dragging productivity down due to their low-productivity and due to their negative spillovers on healthier firms.[2] Zombies are thus part of the explanation to the paradox of a global slowdown of productivity during a period of technological and educational progress (Andrews et al., 2016).

These results are also present in the case of Portugal. Blattner et al. (2019) show the process of evergreening in 2011, as undercapitalized banks rolled over the debt of the financially stressed firms to delay loss recognition. Gouveia and Osterhold (2018) showed an important prevalence of zombies in some sectors: for instance, in the manufacturing sector, 20% of capital and 15% of labor were sunk in zombie firms in 2013.

In this paper, we aim to complement the evidence on capital misallocation among Portuguese firms that are hampering economic growth. This work follows the line of thought started by Hsieh and Klenow (2009) and Gopinath et al. (2017). We estimate the effects of misallocation on the aggregate TFP of the Portuguese manufacturing sector.[3]

We extend the misallocation results in Gopinath et al. (2017) in a number of ways. Firstly, our database contains the universe of all Portuguese firms in the manufacturing sector, in contrast to the one used in the original paper, Orbis, which does not have all firms and can leave the smaller firms under-represented. Secondly, we extend the time period, from 2013 to 2017, a period of recovery of the Portuguese economy. Thirdly, we re-do the analysis with a richer measure of capital stock, computed by Gouveia and Pereira (forthcoming). Gopinath et al. (2017) rely on the accounting value of fixed assets, which is a rather imperfect measure of the firm capital stock. Our goal is to understand if the practice

[2]These negative spillovers are mainly due to the crowding out of financial and human resources, that could potentially be used by healthy firms. Examples of these distortions are increasing wages above productivity or depressing non-zombie market shares (McGowan et al., 2017).

[3]We focus on the manufacturing sector because it allows comparability with the misallocation literature and it is the sector that most adjusts to the theoretical models of production. It is also, according to Statistics Portugal (INE), responsible for around 15% of Gross Value Added and a quarter of the employment in Portugal in 2017.

of relying on fixed assets as a proxy of capital stock significantly impacts the results.

By replicating Gopinath et al. (2017) methodology for the period 2006-2012 with the universe of manufacturing firms, we reach broadly the main conclusions. We show that resource misallocation increased from 2006 and confirm that the boost in TFP was due to the extensive margin (i.e. new firms entering and firms exiting). Extending the analysis for the period 2013-2017 shows that there was no change in the trend pattern of misallocation.

Finally, we show that using a more robust measure of capital stock significantly changes the results. Although that from 2006 to 2017 the observed TFP decreases in both samples, we confirm that the extensive-margin is performing better than the intensive one and document two additional results, contradicting the initial ones: (i) we find a declining economic potential of the manufacturing firms, measured by a hypothetical efficient-level TFP, likely driven by the destruction of productive capital during the period; and (ii) a reduction in capital misallocation, as the actual TFP declined less than the theoretical one.

The remainder of the paper is organized as follows: Section 2 provides an overview of the recent literature on resource misallocation, Section 3 describes the data used, Section 4 replicates the methodology of Gopinath et al. (2017), Section 5 uses the alternative measure of capital stock to estimate productivity, and Section 6 discusses policy implications and conclusions.

2 Literature on Misallocation

Banerjee and Duflo (2005) were two of the first authors to argue that there is not an aggregate production function of the economy. The hypothesis of optimal resource allocation does not verify, hence resources are not necessarily allocated to the firms with a higher TFP, harming the growth of the economy.[4] Thus, resource allocation within the economy is an important factor behind the economic growth differences between countries.

Empirical studies support this argument. There has been a wide consensus that financial distortions pre and during a crisis can cause aggregate TFP to decrease, as documented

[4]Financial frictions have been widely documented to be one of the causes of these distortions that cause misallocation. One example of first to model these distortions were Kiyotaki and Moore (1997). They endogenize economic cycles and argue that financial frictions, which interact dynamically with the credit size, may create a negative hysteresis effect on the economy.

in Argentina (Sandleris and Wright, 2014), Chile (Oberfield, 2013), Colombia and South Korea (Midrigan and Xu, 2014). In the US, literature has also documented that misallocation increases during financial recessions (Bloom et al., 2018), due to uncertainty.

Hsieh and Klenow (2009) propose a model of heterogeneous firms in a monopolistic competition that connects efficiency in resource allocation with aggregate TFP. They continue the work of Restuccia and Rogerson (2008), starting with the problem faced at the firm-level of maximizing profit with a distortion in the acquisition of capital. Empirically, they show that if China and India had the same levels of "efficiency" on resource allocation as the US, their TFP could increase, respectively, almost 50% and 60%.

This line of thought, that estimates the effects of capital misallocation on the aggregate TFP using firm-level data, was used by Gopinath et al. (2017). They link the decline in real interest rates and the increased misallocation of capital at firm-level with the aggregate TFP of the economy leading to the crisis in the Spain and Italy (Cette et al., 2016).

In the Hsieh and Klenow (2009) model, an increase in the dispersion of MRPK may be indicative of distortions, as it indicates that an efficient allocation is not taking place. They give the example of two companies that have exactly the same characteristics, except one. One can get access to credit with a lower interest by a public bank because it has government connections, whereas the other cannot. According to the neoclassical result that firms equalize the interest to the MRPK, the company with the government connections will get the credit, even though its capital is marginally less productive.

If because of a distortion a less productive company can get access to lower interest rates than its counterparts, capital gets misallocated, contributing to a lower aggregate TFP. For Gopinath et al. (2017) this is what happened in southern European economies due to the entrance in the Eurozone.

The last remark is about the data usually used in literature. Due to our data availability, we are able to estimate an improved measure of capital stock improving PIM. Our research is also related to Oberfield (2013) or Bloom et al. (2018) who suggest the utilization of the PIM to compute a measure of capital value as an alternative to the one used in most literature, like Hsieh and Klenow (2009) or Gopinath et al. (2017), who use the book value of the fixed assets.

3 Data

We use firm-level data of the Micro-Lab of the Bank of Portugal from *Informação Empresarial Simplificada* (IES), covering all of the Portuguese population of firms.[5] Our data covers the period from 2006 to 2017. We have access to the firm-level balance sheet and profit and loss accounts, on an annual basis, from turnover to wage bills and tangible assets, with the respective breakdown of asset type. Likewise, we have characteristics about the firm, its year of origin, its number of employees and industry. The main advantage of our datasets is that we have information about small and medium-sized firms, which usually lack in literature.

We can identify sub-industries, within the sector, as firms are classified according to the Statistical Classification of Economic Activities in the European Union, Revision 2 (NACE Rev. 2). The value of the fixed assets is deflated using one-digit sector specific gross fixed capital (GFCF) formation deflators, provided by Statistics Portugal.

We consider firms that are operating businesses, that have at least one employee after the first year and that have positive values of sales.

We, then, follow the cleaning process of Gopinath et al. (2017) to ensure comparability. We drop firm-year observations with missing, negative or zero wage bills. We further eliminate observations with negative, zero or missing fixed assets or capital stock. We drop observations with values of liabilities lower or equal to zero. We drop the Capital-Labor Ratio and drop firms that in any year are in the lower 0.1 percentile of the distribution. We drop observations that are higher than 99.9 percentile or lower than 0.1 percentile. We create the ratio of gross value added (GVA) to wage bill and drop values that are not within the 1 and 99 percentile. In the end, we winsorize all relevant variables, the sum of tangible and intangible fixed assets, wage bill, capital and GVA by the 1 and 99 percentile. All the measures calculated afterwards are also winsorized at 0.1 and 99.1 to cover for outliers that highly affect measures.

To understand better the patterns of productivity, we divide the sample between Full and Permanent Sample. The latter only contains firms that were in the dataset from 2006 to 2017, after all cleanings. The Full Sample has 38051 unique firms and 252557 observations and the Permanent Sample has 9704 firms and 116448 observations.

[5] Every Portuguese firm must fill IES as it is mandatory. It is reported to the Bank of Portugal.

Table 1: Descriptive Statistics of the Full Sample

Variable	Unit	Mean	Std.Dev	P25	P50	P75	Max	Min
GVAfc	10^3€	631	1556	72	162	448	11500	11
Fixed Assets	10^3€	658	1978	18	77	344	14600	0,4
Capital Stock	10^3€	1087	14900	23	94	404	2590000	0
Wage Bill	10^3€	255	604	26	68	194	4376	2,4
Employees	1	25	76	4	9	21	4540	1

Source: Author's own computation using IES. The values are from 2006 to 2017.

Table 2: Descriptive Statistics of the Permanent Sample

Variable	Unit	Mean	Std.Dev	P25	P50	P75	Max	Min
GVAfc	10^3€	901	186	119	269	752	11500	11
Fixed Assets	10^3€	922	2322	43	166	617	14600	0,4
Capital Stock	10^3€	1646	21340	53	201	738	2590000	0
Wage Bill	10^3€	355	709	46	110	312	4376	2,4
Employees	1	35	92	7	13	30	4540	1

Source: Author's own computation using IES. The values are from 2006 to 2017

4 Misallocation in Portugal

In this section, we explore the misallocation facts in Portugal. We use the model developed by Hsieh and Klenow (2009) and Gopinath et al. (2017). Reproducing their methodology with a larger database, our goal is to validate the findings of Gopinath et al. (2017) and understand what happened during the recovery years, after 2012. Furthermore, by having the Full and Permanent Sample, we are able to analyze the intensive margin of productivity.

4.1 Base Framework

Using the Dixit-Stiglitz Model, the economy is represented by a monopolistic market with N heterogeneous firms, indexed by i in sector s at the end of the year t. Industries are defined by their four-digit industry classification. Total industrial output Y_{st} is given by a constant elasticity substitution (CES) function:

$$Y_{st} = \left[\sum_{i=1}^{N_{st}} D_{ist} (y_{ist})^{\frac{\epsilon-1}{\epsilon}} \right] \tag{1}$$

where Y_{st} stands for total industry output of sector s at the end of year *t*. *D* is an idiosyncratic demand shifter of *i*'s varieties. y_{ist} represents the total output of firm i and ϵ the elasticity substitution that the firm *i* faces. Firms face an isoelastic demand function:

$$y_{ist} = \left(\frac{p_{ist}}{P_{st}} \right)^{-\epsilon} (D_{ist})^{\epsilon} Y_{st} \tag{2}$$

where P_{st} is the price of the industry output Y_{st} and p_{ist} is the price of firm variety *i*. The individual firms' output is represented by a Cobb Douglas production function, in which *A* represents its physical productivity, *l* labor and *k* capital:

$$y_{ist} = A_{ist} k_{ist}^{\alpha} l_{ist}^{1-\alpha} \tag{3}$$

In our model, it takes a value of 0.35 for all industries within our sector (manufacturing). It is the average capital share of a relatively undistorted developed economy, like Portugal, and makes the results directly comparable to the standards used in literature and Gopinath et al. (2017).

In our computations, $p_{ist}y_{ist}$ is the gross nominal value added by the firm.[6] Afterwards, to get the real output y_{ist}, we divide the nominal value by the output price deflators by sector. Labour input l_{ist} is the wage bill, which is deflated by the same deflator. For labor input, the wage bill is better than the number of employees because it controls for the quality of the labour employed and, thus, allow for a better estimation of the Marginal Rate of Productivity of Labour (MRPL).[7]

We follow Gopinath et al. (2017) and calculated every given dispersion at four digit-industry GVA weighted values. It was done in three steps. Firstly, we calculate the given dispersion for each firm *i* in industry *s* at the end of every year *t*. Secondly, we sum the GVA value of a four-digit industry in the manufacturing sector in each year (the firm is

[6]This measure is calculated by adding services and sales, plus their variation in production, plus capitalized production and any other income minus cost of materials used and the cost of external services received. We add subsidies and subtract indirect taxes to obtain factor prices.

[7]For robustness, using the number of employees, the results are similar. See results in Appendix, Figure 9.

five-digits). Thirdly, we give a time-invariant weight to the industry, which is the average of the GVA share of the industry in all of the years of the sample. These weights will be used from now onwards and, thus, all of our measures reflect variations within industries.

4.2 Capital Market Distortions

To maximize profit, firms choose their price, capital and labour:

$$\max_{p_{ist},k_{ist},l_{ist}} \Pi_{ist} = (1-\tau^y_{ist})p(y_{ist})y_{ist} - (1+\tau^k_{ist})(r_t+\delta_{st})k_{ist} - w_{st}l_{ist} \tag{4}$$

where $p(y_{ist})$ is the inverted demand function faced by firm *i*; *w* are the wages paid to the employees; δ_{st} is the depreciation of the capital, r is the real interest rate; τ^y_{ist} is a distortion that the firm faces that affects equally labour and capital; and τ^k_{ist} is a distortion that only affects the acquisition of capital.

An example of τ^k_{ist} is the higher capital costs that small sized firms face higher interest rates because of the asymmetries of information in the capital market. On the other hand, a firm-specific markup is an example of a τ^y_{ist}, as the prices of firms are heterogeneous. For the purpose of this work, the distortions are exogenous.

The maximizing of Equation (4), subject to (3) yields:

$$\text{MRPL}_{ist} := \left(\frac{1-\alpha}{\mu}\right)\left(\frac{p_{ist}y_{ist}}{l_{ist}}\right) = \left(\frac{1}{1-\tau^y_{ist}}\right) w_{st} \tag{5}$$

$$\text{MRPK}_{ist} := \left(\frac{\alpha}{\mu}\right)\left(\frac{p_{ist}y_{ist}}{k_{ist}}\right) = \left(\frac{1+\tau^k_{ist}}{1-\tau^y_{ist}}\right)(r_t+\delta_{st}), \tag{6}$$

where $\mu = \epsilon/(\epsilon-1)$ is the constant markup of price over marginal cost. To allow for comparability with Hsieh and Klenow (2009) and Gopinath et al. (2017), we normalise ϵ to 3.

Note that a positive value of τ^y_{ist} will drive the marginal productivity of the two factors up and hence decrease capital and labour utilization. High rent costs or government impositions, like taxes on specific products, can affect τ^y_{ist} .

If a company has a lower τ^k_{ist} compared to another company, this company is artificially lowering the MRPK of the economy. An example would be a company that does not face the distortions on the financial market and can get access to subsidized credit from the government.

The economy would not face any distortions if all firms had $\tau^y_{ist} = \tau^y_{st}$ and τ^k_{ist}=τ^k_{st}. This would mean that all firms would face the same distortion (or none). Thus, the resources would be allocated optimally and there would not be a dispersion of MRPL or MRPK in the economy.

Consequently, a higher TFP would be achieved as the determinants of resource allocation would only be the specific demand shifter D_{ist} (consumers demanding a lot of that firm's product) and the firm's physical productivityA_{ist}. Thus, more factors would be allocated to firms with higher productivity.

To illustrate the impact of the dispersion, we follow Hsieh and Klenow (2009) and Gopinath et al. (2017), we calculate the Total Factor Productivity Revenue (TFPR) at firm level i:

$$\text{TPFR} := p_{ist}A_{ist} = \frac{p_{ist}y_{ist}}{k^{\alpha}_{ist}l^{1-\alpha}_{ist}} = \mu\left(\frac{\text{MRPK}_{ist}}{\alpha}\right)^{\alpha}\left(\frac{\text{MRPL}_{ist}}{1-\alpha}\right)^{1-\alpha} \tag{7}$$

MRPK and MRPL are affected by τ^y_{ist} and MRPK by τ^k_{ist}. An increase of its value will make the TFPR go up, showing that idiosyncratic distortions can affect the dispersion of TFPR in the economy and consequently the sectoral total TFPR and TFP.

After presenting part of the methodology and the intuition behind the model used by Gopinath et al. (2017), we now present the results.

4.3 Dispersion of MRPK in Portugal

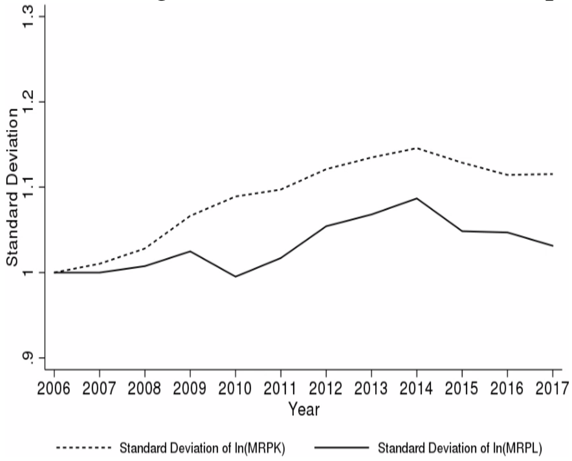
With the previous methodology, we estimate if there are capital distortions in the Portuguese economy and try to find its impacts on TFPR, contrasting the results between the Full and Permanent Sample.

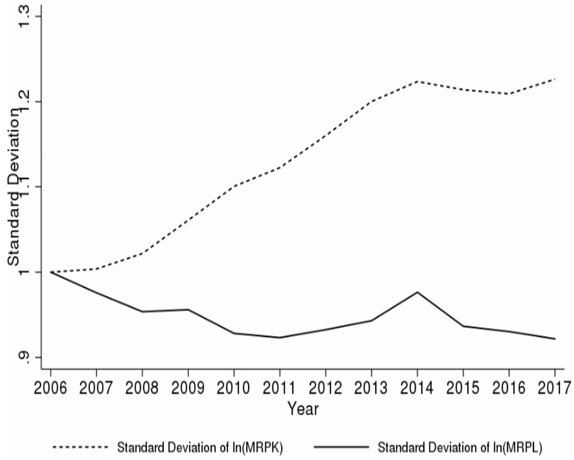
To measure dispersion we use the value of the standard deviation of the logarithms.[8] Standard deviation is used to understand if there is a wide range of different firm's productiveness in the Portuguese economy and if it is increasing or not. The following figures present the calculations for Full and Permanent Sample, left and right respectively. We normalize the value to 1 to get a better interpretation.

In both samples of Figure 1, the changes in the dispersion of MRPK are larger than in the ones of MRPL. This difference can be attributed to the distortion τ^k_{ist} that only affects MRPK, as presented in Equation (6).

[8]We use logarithms in order to get less skewed numbers and reduce the impact of outliers on the sample.

Figure 1: MRPK and MRPL Dispersion in Full and Permanent Sample





Looking at the Full Sample, we see a larger dispersion of MRPK than in MRPL. This difference in the permanent is even larger. In the Full Sample, MRPK increases around 10% and in the Permanent Sample 20%, indicating that the problems of productivity may be larger in the intensive margin rather than in the extensive margin.

4.4 Dispersion of TFPR

To understand the impact of the dispersion of capital on productivity, it is important to comprehend the relation between the dispersion of MRPK and the TFPR. With the dispersion of TFPR, we see if the differences between the frontier and laggard firms within the manufacturing sector are increasing or decreasing. Likewise, it is important to understand if capital is allocated to companies with a higher TFPR. Like in Hsieh and Klenow (2009), our analysis relies on a Cobb Douglas function, so the variation of MRPK can be written in the following way:

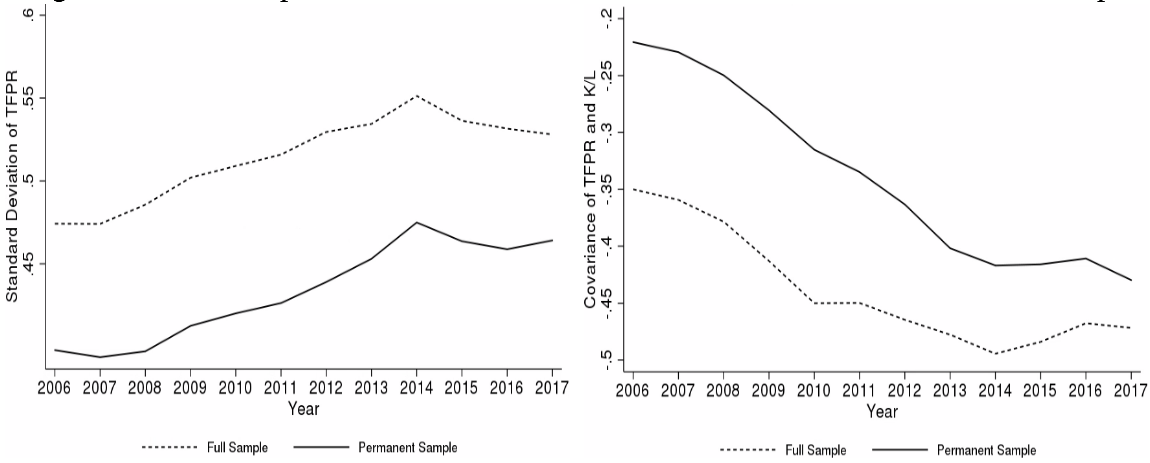
$$\text{Var(mrpk)} = \text{Var(tfpr)} + (1-\alpha)^2 \text{Var}\left(\log\left(\frac{k}{l}\right)\right) - 2(1-\alpha)\text{Cov}\left(\text{tfpr}, \log\left(\frac{k}{l}\right)\right) \quad (8)$$

$$\text{Var(mrpl)} = \text{Var(tfpr)} + \alpha^2 \text{Var}\left(\log\left(\frac{k}{l}\right)\right) - 2\alpha\text{Cov}\left(\text{tfpr}, \log\left(\frac{k}{l}\right)\right) \quad (9)$$

where mrpk=log(MRPK), mrpl=log(MPRL) and tfpr=log(TFPR).

Taking into account the previous results of Figure 1, using fixed assets as our capital measure, it is expected that if the dispersion of MRPK is increasing, the covariance between *k/l* and TFPR is decreasing, like in Gopinath et al. (2017), as MRPL is stable. We calculate these values for the Portuguese manufacturing sector.

Figure 2: TFPR Dispersion and its Covariance with K/L in Full and Permanent Sample



From Figure 2, in both samples, the dispersion of TFPR is increasing, indicating more difference between the frontier and laggard firms, and the covariance between TFPR and *k/l* is decreasing, suggesting that capital is being allocated to firms with lower TFPR.

The Permanent Sample has a lower standard deviation than the Full Sample, indicating what would be expected for firms that stay in the sample for 11 years. The covariance of TFPR and *k/l* is also higher, although it decreases more relatively. This further indicates a problem of misallocation in the Full and Permanent Sample, but it may be even larger on the latter.

To confirm the dimension of these effects, we need to estimate the measure of misallocation. To test this hypothesis we will follow, again, the methodology of Hsieh and Klenow (2009) and Gopinath et al. (2017). In order to do so, we need to see the difference between the observed TFP and an efficient TFP, the first best allocation of resources. Our goal is to contrast an economy where there are no distortions. Thus, we are able to measure the impact of capital distortions on the productivity of the Portuguese manufacturing sector.

4.5 Observed and Efficient TFP

After detecting the symmetric dispersion in the MRPK and in the TFPR in both samples, we look at the difference between the real TFP and the TFP in which all resources are efficiently allocated.

The TFP of a sector in the economy is defined as the ratio of total industry output by the factors employed to produce it:

$$\text{TFP}_{st} = \frac{Y_{st}}{K_{st}^{\alpha} L_{st}^{1-\alpha}} \tag{10}$$

where Y_{st} is the total gross value added, K_{st} is total industrial capital and L_{st} is total labor employed.

We use the methodology of Hsieh and Klenow (2009) and Gopinath et al. (2017) to calculate the efficient TFP. TFP can be written as the average value of the TFPR of the sector divided by the Price P_{st} that faces. We rewrite it in the following way[9]:

$$\text{TFP}_{st} = \frac{\overline{\text{TFPR}}_{st}}{P_{st}} = \left[\sum_i \left((D_{ist})^{\frac{\epsilon}{\epsilon-1}} A_{ist} \frac{\overline{\text{TFPR}}_{st}}{\text{TFPR}_{ist}} \right)^{\epsilon-1} \right]^{\frac{1}{\epsilon-1}} \tag{11}$$

where D_{ist} is the demand shifter and A_{ist} is the physical productivity. The product of these terms is the firm's productivity Z_{ist}. Like Hsieh and Klenow (2009), because of model misspecification or measurement error, the efficient TFP may be overestimated.

Our goal is to find the measure of misallocation. Thus, to build it, we need an estimation of Z_{ist}. If we look at the assumptions on the demand and production that we used to arrive at (11), Z_{ist} can be given as [10]:

$$Z_{ist} = \left(\frac{(P_{st} Y_{st})^{-\frac{1}{\epsilon-1}}}{P_{st}} \right) \left(\frac{(p_{ist} y_{ist})^{\frac{\epsilon}{\epsilon-1}}}{k_{ist}^{\alpha} l_{ist}^{1-\alpha}} \right) \tag{12}$$

where $P_{st}Y_{st}$ is equal to $\sum_i p_{ist} y_{ist}$.

If there was an efficient allocation of resources, the TPFR_{ist} would be equal to the $\overline{\text{TFPR}}_{st}$, as there were not distortions taking place in the market. Factors would be allocated to higher productive firms, the firm-prices of variety *i* would decrease, equalising TFPR across firms. If we substitute it in (11), the efficient TFP would be given as:

$$\text{TFP}_{st}^{e} = \left[\sum_i Z_{ist}^{(\epsilon-1)} \right]^{\frac{1}{\epsilon-1}}. \tag{13}$$

In an efficient market, the determinant of total TFP is the firm's productivity Z_{ist}.[11]

[9]To reach (11), put the industry price index in the TFP definition, $P_{st} = (\sum_i (D_{ist})^{\epsilon} (p_{ist})^{1-\epsilon})^{\frac{1}{1-\epsilon}}$, price of the firms is $p_{ist} = \frac{\text{TFPR}_{ist}}{\text{A}_{ist}}$, and an equalized TFPR per setor $\overline{\text{TFPR}}_{st} = \frac{P_{st} Y_{st}}{K_{st}^{\alpha} L_{st}^{1-\alpha}}$.

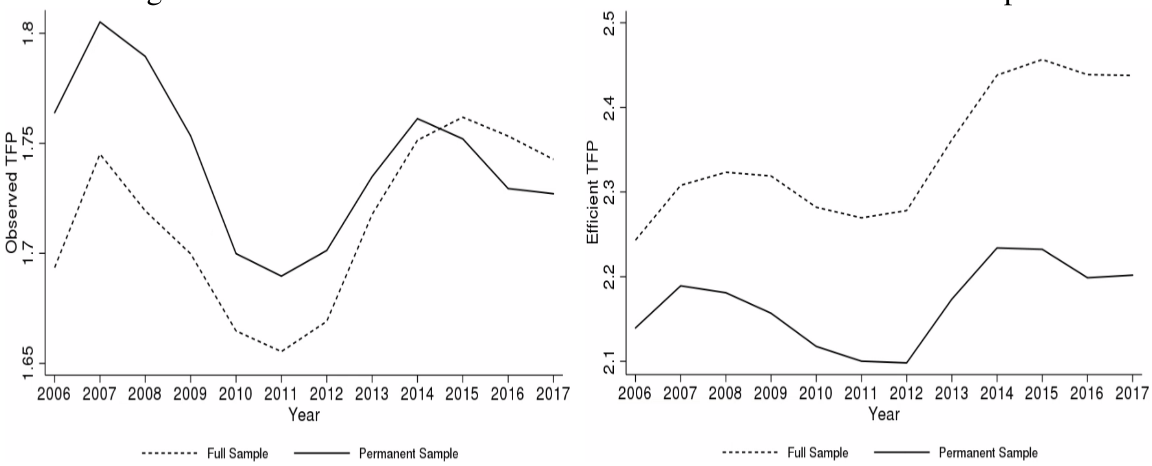
[10]To arrive at (12), $Z_{ist} = A_{ist} D_{ist}^{\frac{\epsilon}{1-\epsilon}} = \frac{D_{ist}^{\frac{\epsilon}{1-\epsilon}} y_{ist}}{k_{ist}^{\alpha} l_{ist}^{1-\alpha}}$, where $D_{ist}^{\frac{\epsilon}{1-\epsilon}} = \left(\frac{p_{ist}}{P_{st}} \right)^{\frac{\epsilon}{\epsilon-1}} \left(\frac{y_{ist}}{Y_{st}} \right)^{\frac{\epsilon}{1-\epsilon}}$.

[11]Efficient TFP is also influenced by ϵ. To robust our results, we estimate the efficient TFP under ϵ equal to 7.2 as calculated by Amador and Soares (2014), for the Portuguese manufacturing sector in the 2006-2009 period. In the Appendix, Figure 10, we observe that the estimated efficient TFP would be higher, increasing the value of the measure of misallocation.

The difference between the following estimations is that we are going to contrast the difference between the TFP observed in reality and the one that is observed in a first-best allocation, in which we assume that TPFR$_{ist}$=$\overline{\text{TFPR}}_{st}$.

The following calculation is new, as Gopinath et al. (2017) did not present the efficient and observed TFP of the Portuguese economy, only the measure of misallocation.

Figure 3: Observed and Efficient TFP in the Full and Permanent Sample



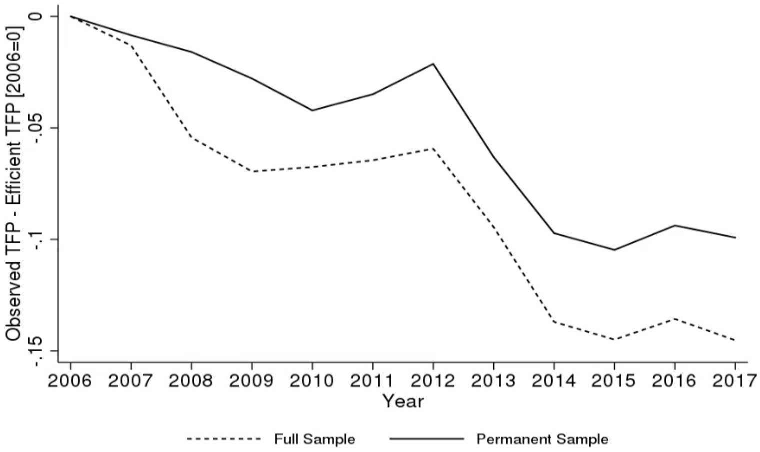
Analyzing Figure 3, in 2006, the observed TFP of the Permanent Sample was higher than the Full Sample. It decreased in both samples, from 2007 to 2011, having a high correlation with the years running to the crisis. The observed TFP of the Permanent Sample recovered to similar levels in 2014, although it dropped since, having a lower value than the Full Sample. In 2017, it was lower than the Full Sample, showing that, in the intensive margin, productivity is decreasing.

The problem of productivity is rooted in the manufacturing sector, as its value of the most enduring firms has slumped. This contributes to the narrative that low productive capital is being financed artificially, as lower productive firms do not exit the market and hinder the growth of the economy.

In terms of efficient TFP, the value of the Full Sample is higher than the one in the Permanent Sample. This is explained by the fact that distortions are higher in the process of entering and exiting the marker. Likewise, its variation suggests that there are firms with a higher Z_{ist} than the average that exit the market in the years prior to the crisis. This also contributes to the narrative of misallocation.

To get a proper measure of misallocation, we need to analyze the time variation between the difference of the Observed TFP and the Efficient TFP.

Figure 4: Misallocation in Full and Permanent Sample



In Figure 4, the misallocation in the Portuguese manufacturing sector increased, especially after 2012, in the post-crisis. Both Full and Permanent Samples have the same trends, although the misallocation in the Full Sample is higher, as expected because of the financial frictions faced by firms entering and exiting the market. Even so, it would be expected that, during the crisis, the cleansing effect would make laggard firms exit the economy, as well as, only letting high productive firms enter the market. Even though the observed TFP increased, this measure of misallocation shows that the extensive margin could have had a higher impact on productivity.

In spite of the misallocation being lower in the Permanent Sample, this highlights how the manufacturing sector is facing a slump in terms of TFP, as the most enduring firms in the economy are not contributing to the optimal allocation of resources.

The misallocation in the Permanent Sample is fuelled by both an increase in the efficient TFP and a decrease in the observed TFP, as seen in Figure 3, while in the Full Sample it is only fuelled by the increase of efficient TFP.

4.6 Evidence of Financial Misallocation

After seeing the measure of misallocation, we provide a hint of what could be leading the misallocation of capital in the Portuguese manufacturing sector.

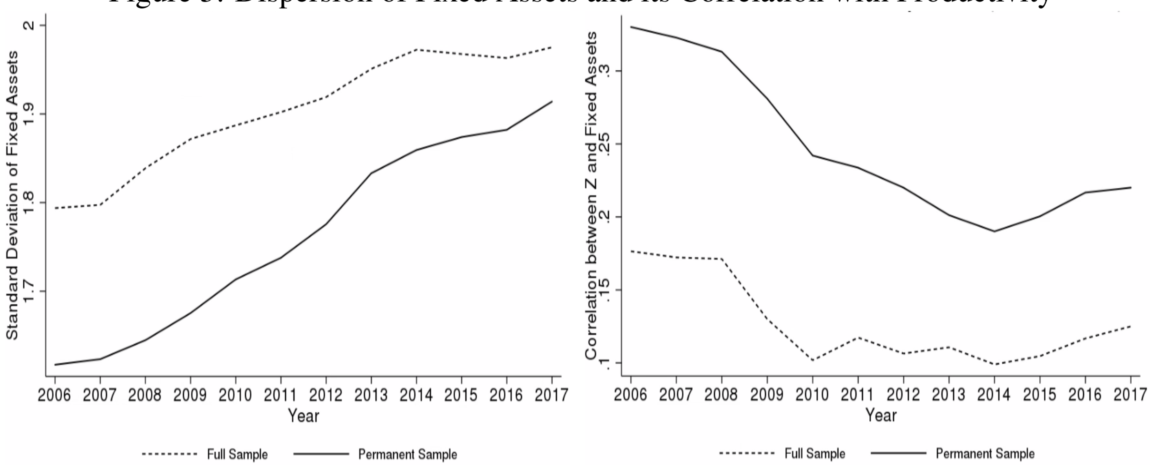
In Gopinath et al. (2017), their main goal is to test if because of the decline of the real interest rate in the southern European countries, there were more capital inflows to low productive firms. We contribute to the literature by extending this finding through the crisis period, where the European Central Bank reference rates have been historically low.

In order to do so, Gopinath et al. (2017) establish a connection between the MRPK dispersion and the firm's productivity Z_{ist}, by writing the dispersion of the former being influenced by the dispersion of the latter, the dispersion of k_{ist}, and the covariance between the Z_{ist} and k_{ist}:[12]

$$\text{Var}_i(\log \text{MRPK}_{ist}) = \gamma_1 \text{Var}_i(\log Z_{ist}) + \gamma_2 \text{Var}_i(\log k_{ist}) - \gamma_3 \text{Cov}_i(\log Z_{ist}, \log k_{ist}) \quad (14)$$

In Equation (14), the variation of MRPK is not only determined by the firm's productivity log(Z_{ist}). If the log(k_{ist}) increases, the log(MRPK) variation across firms increases, without any change on the productivity. An increase in log(k_{ist}) or the decrease between the covariance of log(Z_{ist}) and log(k_{ist}) will make the dispersion increase, affecting the TFPR and TFP as previously seen.

Figure 5: Dispersion of Fixed Assets and its Correlation with Productivity



Looking at Figure 5, both samples have an increase in the standard deviation of the fixed assets and a decrease in the correlation between the firm's productivity and fixed assets. This means that the dispersion of k_{ist} is affecting the variation of the MRPK, while the productivity has not increased, as previously seen in Figure 3.

We choose to put the correlation instead of the covariance, to show the direct relation of the increased dispersion of fixed assets with Z_{ist}.[13] If the correlation is decreasing, it means that capital is not translating or being translated into productivity.

[12] $\gamma_1 = \left(\frac{\varepsilon-1}{1+\alpha(\varepsilon-1)}\right)^2$, $\gamma_2 = \left(\frac{1}{1+\alpha(\varepsilon-1)}\right)^2$ and $\gamma_3 = \frac{2(\varepsilon-1)}{(1+\alpha(\varepsilon-1))^2}$. Equation (14) is obtained by putting the solution of l_{ist} in Equation (6) and treating k_{ist} as given.

[13] The results are similar, see Appendix, Figure 11.

A possible reason for that capital to subsist in the economy is that it is being artificially financed by distortions as seen in Equation (6). In Figure 5, this effect is seen in both samples. This can be seen as the first causal evidence for the dispersion of MRPK and subsequent negative consequences in the TFP.

Gopinath et al. (2017) continue their paper introducing a model, in which they deduced that the entrance of the southern European countries in the single European currency led to the financial misallocation to lower productive firms insider their respective economies, creating a causal relation. As we have the same results using the same methodology, we presume we would obtain the same findings.

We choose to focus now on another important issue in studying the productivity of capital, the quality of the data. In order to improve the accuracy of these results, we will now present an enhanced measure of capital, capital stock.

5 Misallocation in Portugal using an improved measure of capital stock

In the previous section, we reached the same results of Gopinath et al. (2017) and extended them to 2017, using the same methodology and a larger database of the Portuguese manufacturing sector.

To further extend our analysis, we propose to use the same methodology, but contrast the previous results with another measure of capital. This measure is called capital stock, in contrast to the fixed assets used previously and in Gopinath et al. (2017). Our goal is to see if the results change using a different capital measure.

It is widely reported why fixed assets may not be the best measure of capital, but it is usually used due to the lack of better information. Due to our data availability, we are able to improve the Perpetual Inventory Method (PIM). This method accounts for the economic value of the asset rather than its book value, being a more accurate measure of capital. The biggest difference is that treating capital as a stock we are able to understand more its dynamics rather than on accounting standards, in which its value mostly reflects business decisions. In the next sub-section, we explain its details. We afterwards use the methodology of Gopinath et al. (2017) to obtain the results.

5.1 Capital Stock explained

In this paper, the capital stock was calculated according to the methodology used in Gouveia and Pereira (forthcoming).

The total capital stock of firm *i*, in constant 2017 prices, of sector *s* at the end of the year *t* is the sum of all the asset types *a* owned by the firm:

$$K_{i,s,t} = \sum_{a=1}^{A} K_{a,i,s,t} \tag{15}$$

Our measure of capital is based on the PIM. The real capital stock of a tangible asset *a* for firm *i* of sector *s* at the end of the year *t* is given by:

$$K_{a,i,s,t,} = K_{a,i,s,t-1} * (1 - \delta_{a,s,t}) + I_{a,i,s,t} + \Delta V_{a,i,s,t} \tag{16}$$

where *K* stands for capital stock, δ for the economic rate of depreciation, *I* for investment and ΔV for changes in volume (i.e changes that affect the quantity of the assets in the production process, but are not taken into account in either fixed assets or investment).

The economic rate of depreciation δ for the different asset types is taken from the OECD STAN database, at the two-digit sectorial level. The capital is at constant prices of 2017.

Gouveia and Pereira (forthcoming) adapt and improve the PIM the following ways:

1. As we have the capital breakdown by type, we have different series for land, buildings, basic equipment, transport equipment, administrative equipment, other equipment and capital in progress. It allows us to apply sectorial and asset-specific economic depreciation rates at the two-digit level. Consequently, we have a better estimate of firm-level economic depreciation.

2. Other changes in volume allow us to correct outflows and inflows that are not taken into account in the investment variable. This is an asset that is transferred within the firm to be used at the production process, such as transfers or write-offs, that are not under fixed assets. In the traditional PIM, this does not fall into investment, under calculating the capital stock.

3. During the time period 2006 to 2017 there was a structural change in the accounting standards of Portugal. Until 2010, *Plano Oficial de Contas* (POC) switched to *Sistema de Normalização Contabilística* (SNC). This does not create problems for our

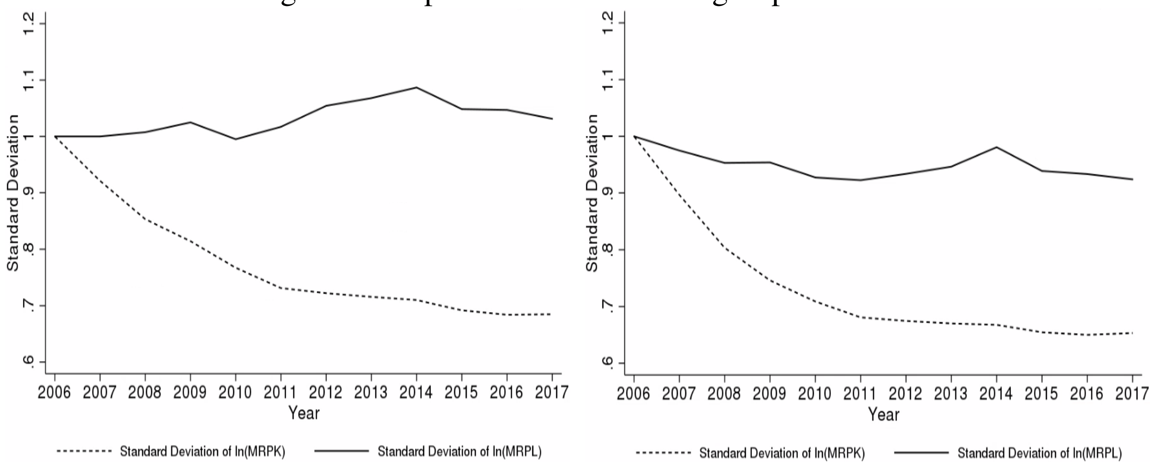
dataset as specifically in the manufacturing sector, the value of the fixed assets did not change in the calculations of Pereira and Gouveia (forthcoming).

Our measure of capital stock does not include intangible assets in comparison with the previous measure, fixed assets. This does not harm comparability as manufacturing sector does not have a significant value of intangible assets, as the biggest change from POC to SNC was the valuation of intangible assets, and it did not affect the overall value of the manufacturing sector.

5.2 Misallocation Dynamics using Capital Stock

We now present the dispersion of the results from Equations (5) and (6), followed by its consequence in the observed TFP, efficient TFP and measure of misallocation. These values are presented for the Full and Permanent Sample.

Figure 6: Dispersion of MRPK using Capital Stock



In Figure 6, using capital stock as our capital measure, we get the opposite result of the dispersion of MRPK that we got in Figure 1, using fixed assets. Taking into account Gopinath et al. (2017) methodology, it is expected that the degree of misallocation improved significantly over the last years, as since 2006 the dispersion of MPRK decreased significantly compared to the MRPL, that maintains a stable value.

As Equation (8) implies, a decreasing dispersion of MRPK with a stable MRPL will make the variation of TFPR decrease and its covariance with the ratio of capital and labor increase. This would suggest that capital is being allocated to the most productive firms, the opposite of the findings in Figure 2. The Permanent Sample also ends with a slightly lower dispersion than the Full Sample, implying a better allocation than the latter.

To understand if this improved dispersion cause in an improvement of productivity, we estimate the results of the observed and efficient TFP, and the following misallocation measure.[14]

Figure 7: Observed and Efficient TFP using Capital Stock

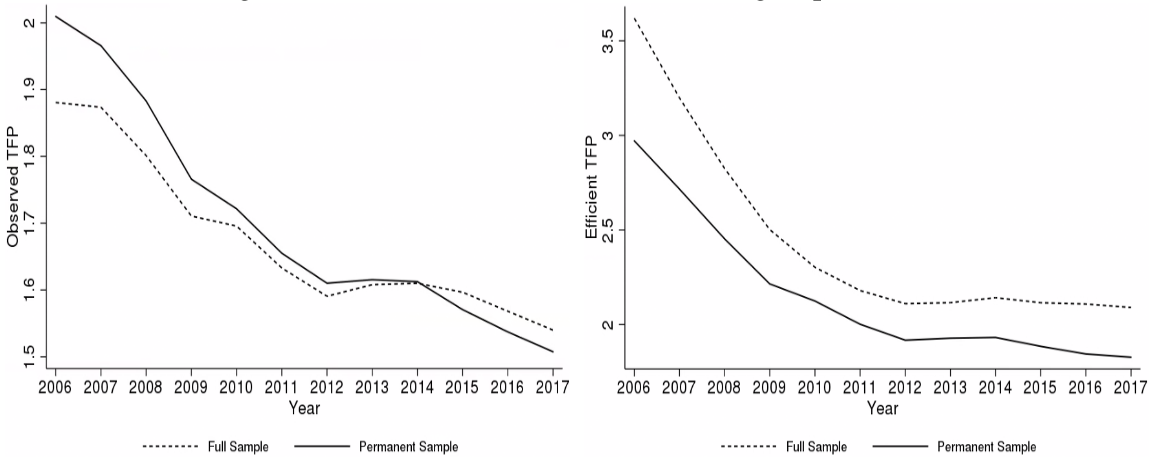


Figure 8: Misallocation in Full and Permanent Sample

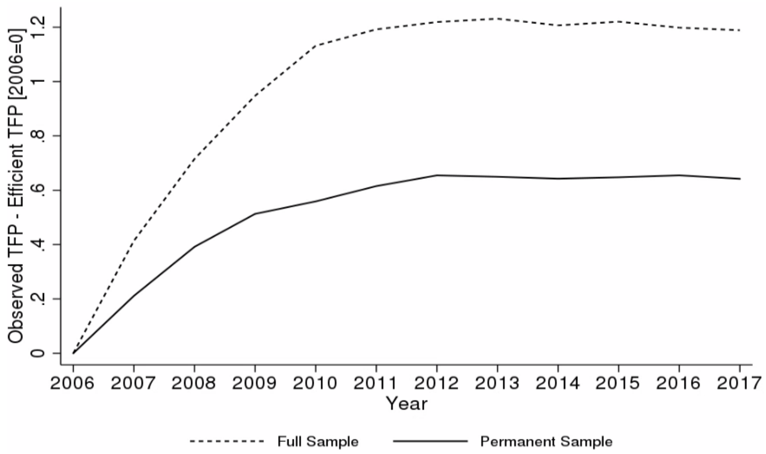


Figure 8 confirms that the measure of misallocation is improving, as the difference between TFP observed and TFP efficient is decreasing. For the Full Sample, this value is around the double compared to the Permanent Sample.

But in Figure 7, it is possible to detect why the results suggest that the misallocation measure dropped significantly over the years. The measure of misallocation is the difference between the observed TFP and efficient TFP. Its decrease was not due to a rise of

[14]The intermediate steps, calculated in the previous section, using capital stock as a capital measure are available in the Appendix, see Figure 12.

the observed TFP compared to the efficient TFP, but because the latter slumped more than the former. This preliminary result indicates that the reason for the improved misallocation was not an improvement of productivity, but an overall deterioration of the firm-level productivity of Portugal.

As explained in Subsection 4.5, the efficient TFP is the TFP that the economy would observe if all the resources were optimally allocated. Using capital stock, the improvement of the measure of misallocation was due to the exit of firms with a high Z_{ist} (firm's productivity) or a significant drop of its value in the remaining ones, rather than an improvement in the observed TFP, as it fell, but proportionally less than the efficient TFP.

Using an improved measure of capital, the observed TFP falls, in both samples, in the years running to the crisis. From 2012 to 2014, the value of the Permanent Sample stabilized, meaning that the only time that the TFP observe did not fall was when Portugal was being hit by the financial crisis, from 2012 to 2014. Parallelly, the value of the Full Sample increased, meaning that more productive firms were entering the market. In 2014 they had a similar value, but, since that year, the value of the Permanent Sample depresses more than the Full Sample.

Although the variations of the observed TFP are different from the previous Section, which uses fixed assets as the capital measures, the analysis done in this section adds robustness to one of the key findings of Figure 4. In both capital measures, the TFP observed is lower in 2017 than in 2006, indicating that the Portuguese manufacturing sector is today less productive.

Another significant preliminary key finding of the left side of Figure 7 is that the firms entering the market as well as the most enduring firms have a significant drop in its Z_{ist}, meaning that even without distortions their productivity is decreasing. This could mean that it is not the distortions only by themselves that are hampering productivity in Portugal, it is the firm's productivity itself that is decreasing or that firms with a higher Z_{ist} are leaving the market.

Furthermore, using different measures of capital, in 2006, the observed TFP of the Permanent Sample was bigger than in the Full Sample. From 2015, the latter started having a bigger observed TFP. We have two different capital measures that make the observed TFP variate distinctly, but both of them make the relation between the Full Sample and Permanent Sample have the same trend. This potentially indicates that there is a decrease of the intensive margin in the productivity of the Portuguese manufacturing sector and that the most enduring firms of the economy are hindering its growth.

To sum up, in this section, capital is treated as stock, implying that it accumulates over the years, depreciating constantly at economic values, making it a more accurate measure of capital. The findings say that the problems found in productivity in Section 4 and Gopinath et al. (2017) can be bigger than expected. In contrast to the value in the previous section, the misallocation measure improved. But this could be happening because of the destruction of productive capital, as, since 2006, the observed TFP decreased around a quarter of its value, both in the Full and Permanent Sample. Furthermore, the dynamics of TFP between samples gives us the hint that the problems related to productivity are affecting the most enduring firms.

6 Conclusion

The goal of this paper is to analyze the patterns of productivity in the Portuguese manufacturing sector. With a database that has firm-level information of all of the Portuguese manufacturing sector, we apply the methodology of Gopinath et al. (2017) using fixed assets. We move on to explore our findings using an improved capital measure, capital stock. We reach three main results.

First, with a more comprehensive firm-level dataset and the same methodology, we reach the same conclusion as Gopinath et al. (2017) from 2006 to 2012. We further extend it until 2017 and conclude that misallocation of capital has increased in Portugal since 2012, showing that neither the financial crisis or any policy neutralized its trend.

Second, with an improved capital measure, capital stock, our results change significantly: (i) our preliminary findings show that the improvement of the misallocation measure may be due to the destruction of productive capital as the observed TFP in both samples decreases less than our hypothetical efficient-level TFP; (ii) the Portuguese manufacturing sector is in 2017 less productive than in 2006 as the observed TFP slumps in both samples. Since this capital measure is a stock, these results are economically more accurate.

Third, we conclude that the most enduring firms in the Portuguese manufacturing sector are having a negative impact on productivity. Using both of the capital measures, the observed TFP of the Permanent Sample is higher than the observed TFP in the Full Sample in 2006. But, from 2015, it has a lower value than the one verified in the Full Sample. This finding not only gives robustness to our results since two different capital measures share the same phenomenon, but it also means that the problem of productivity is deeply rooted in the sector. It would be expected that the most resistant firms would be the most healthy in the economy but our findings oppose this hypothesis.

Our limitations are related to the data. Although the book value of the fixed assets is used throughout literature, they do not necessarily provide the correct value of the capital used by the firms. Our analysis with the capital stock makes our results more economically accurate, but the methodology to compute it is a work in progress, which can lead to measurement errors. Hence, the model may overestimate the efficient TFP, as pointed by Hsieh and Klenow (2009), and consequently the measure of misallocation.

Our analysis explores what happened. Studying what were the main drives of why it happened is fundamental to reverse the trends of productivity. Gopinath et al. (2017) point that one of the causes of this misallocation and low productivity may be due to the entrance of the Eurozone and consequent historic low rates. Our results induce this explanation, hinting that policymakers have room to improve the allocation of resources within the economy, especially in the way of how financial markets work and how monetary policy is conducted. Our findings could be exported to the other southern European economies as they faced the same problems as the Portuguese economy and have relatively the same structure.

Extending and improving this methodology to other sectors could also help to understand the relation between the entrance in a single European currency area and capital misallocation. In other sectors of the economy, the misallocation is higher, especially in services, as suggested by Dias et al. (2016a), and understanding its relationship with the single European currency could yield significant value-added to the literature.

We hope to contribute to the end of the endemic growth that the Portuguese economy faces for 20 years by giving highlighting and pointing the problems in the Portuguese manufacturing sector for policymakers to act upon it. Literature shows that productivity is fundamental to end the gap between Portugal and more developed economies. Krugman (1997) said "Productivity in the short run isn't anything, but in the long term is everything." and twenty years of residual economic growth have proven it.

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Appendix

Figure 9: MRPK and MRPL Dispersion using Employees

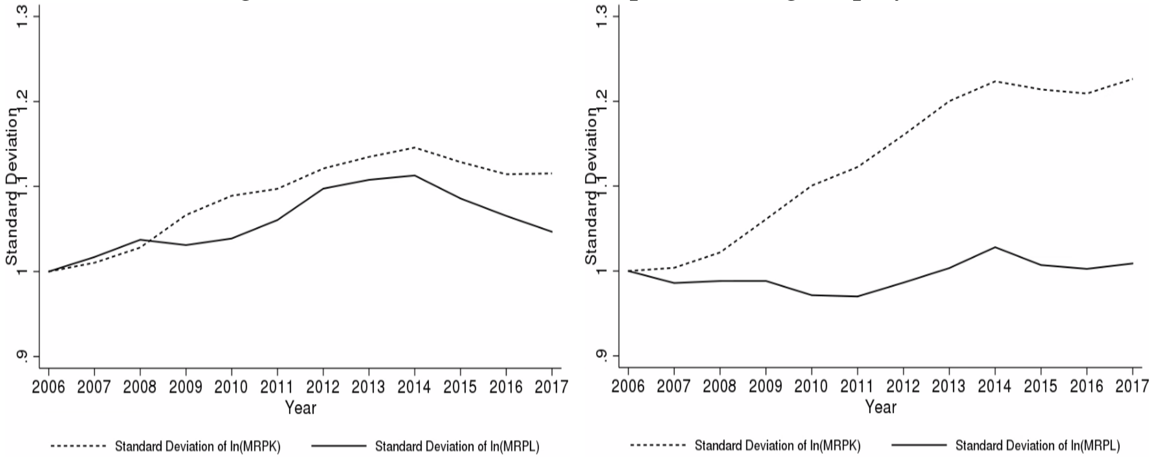

Figure 10: Robustness Check for the Efficient TFP and Measure of Misallocation

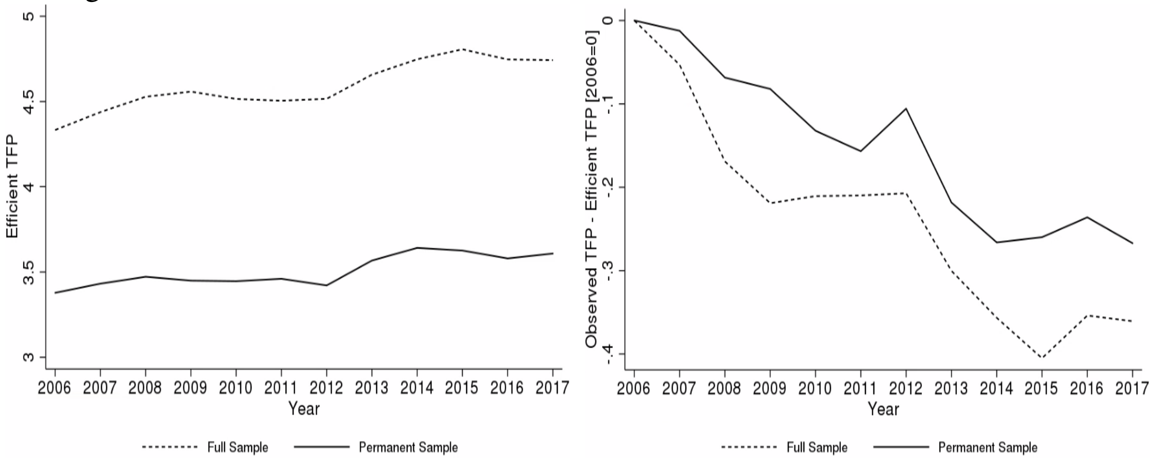

Figure 11: Covariance between Z and Fixed Assets

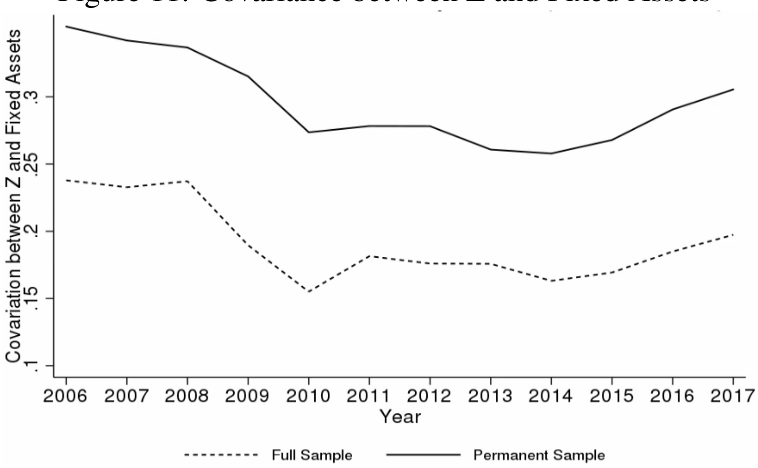

Figure 12: Standard Deviation of TFPR and its Covariance with K/L using Capital Stock